



Results from the Dzero Experiment at the Tevatron

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Representing the Dzero Collaboration**

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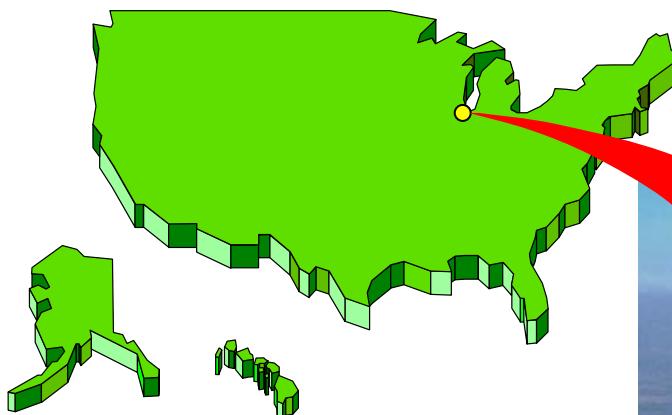


DØ in RunII

- **Center of Mass Energy = 1.96 TeV**
- **Expect 2 fb⁻¹ by end of 2004 (RunIIa),
 15 fb⁻¹ by 2008 (RunIIb)**
- **Goals**
 - Comprehensive study of top quark properties
 - Precise measurements of m_{top} , m_W , A_{FB}
 - Search for new phenomena (SUSY, technicolor,...)
 - Search for the Higgs boson
 - QCD (proton structure, quark compositeness)
 - B-physics (B_s mixing)
- **DØ's strength is high-pT physics**
- **Requires**
 - Measurement of leptons (e, μ), jets, missing p_T
 - Flavor tagging of jets



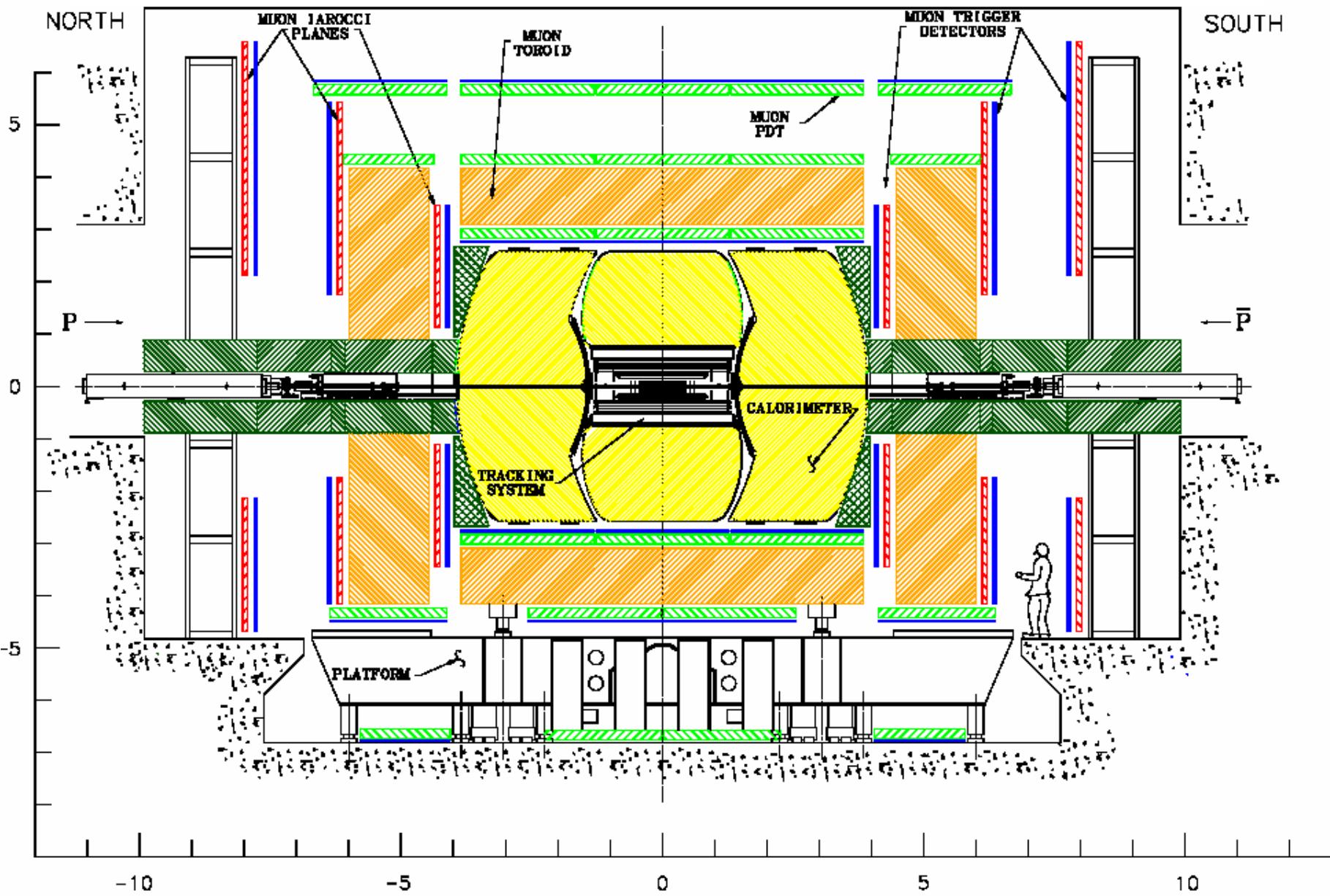
Fermilab



- $p\bar{p}$ collisions
- $E_{\text{com}} = 1.96 \text{ TeV}$
- 396 ns bunch spacing
- Run II peak luminosity
→ now: $2.1 \times 10^{31} \text{ cm}^{-2}\text{s}^{-1}$
- goal: $8.6 \times 10^{31} \text{ cm}^{-2}\text{s}^{-1}$



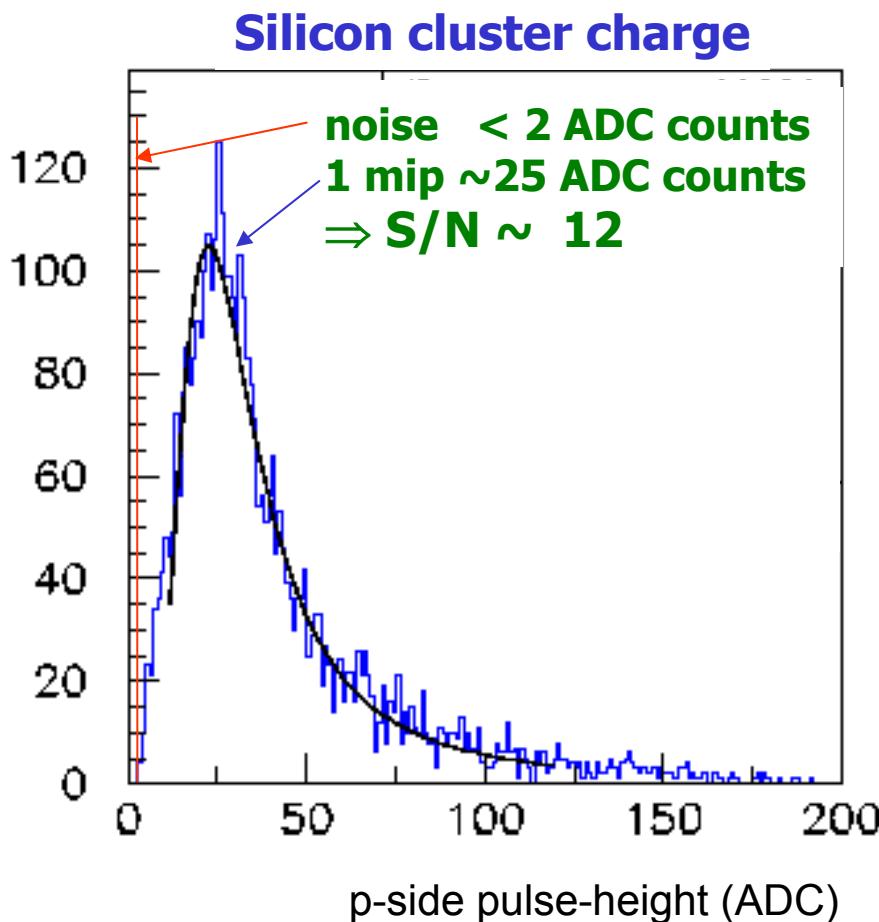
D0 RunII Detector



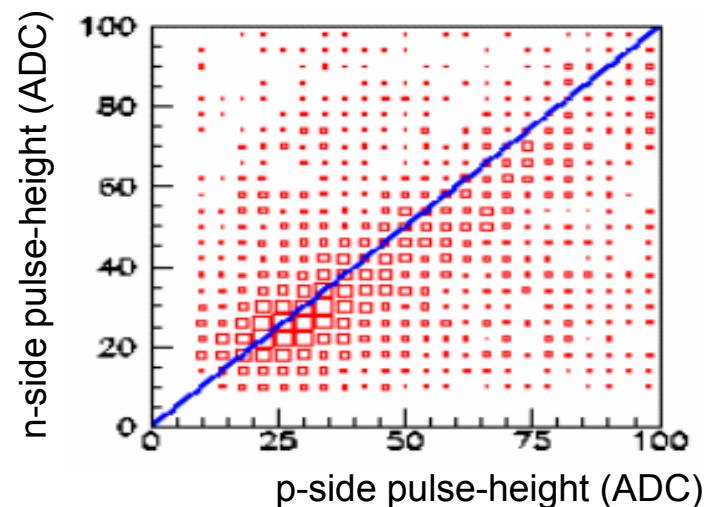


Detector Performance

- **Silicon Tracker**



Charge correlation between p and n-side of a silicon detector



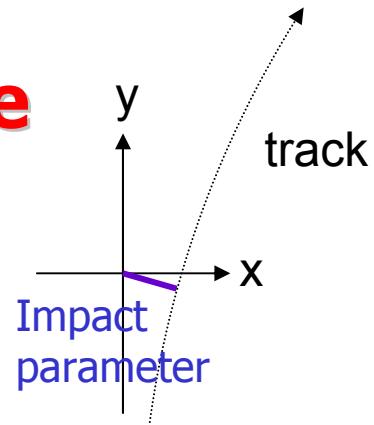
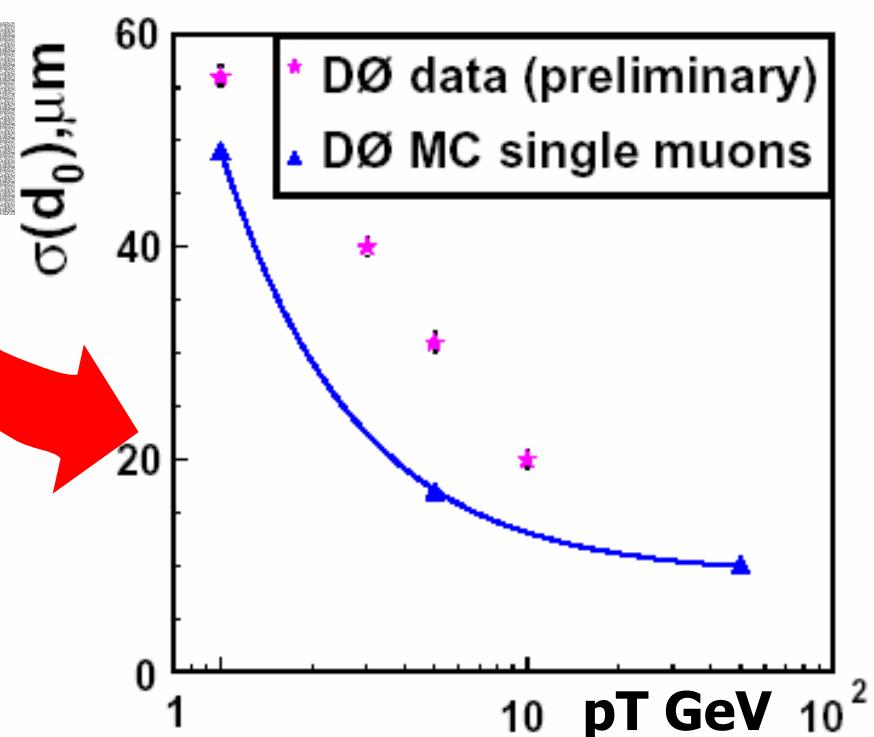
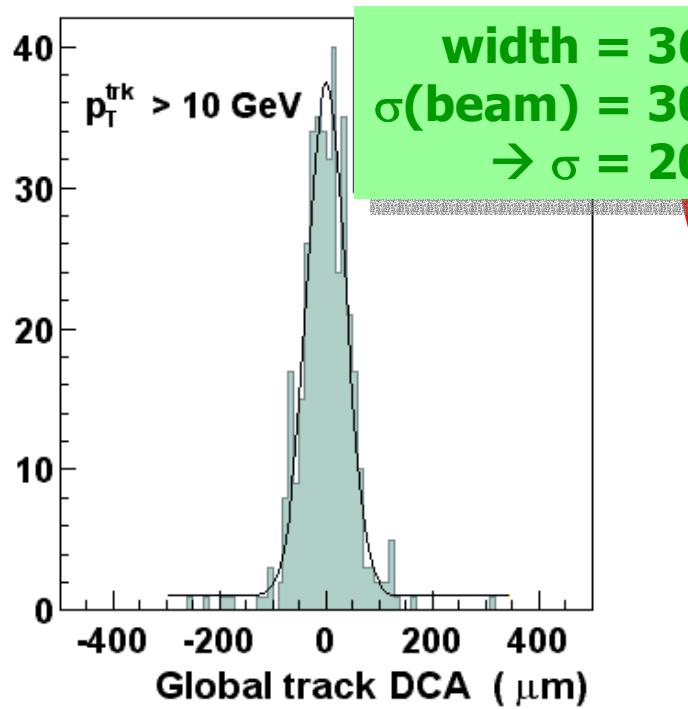
Hit efficiencies >97%



Detector Performance

- Impact Parameter Resolution

Survey-only alignment constants



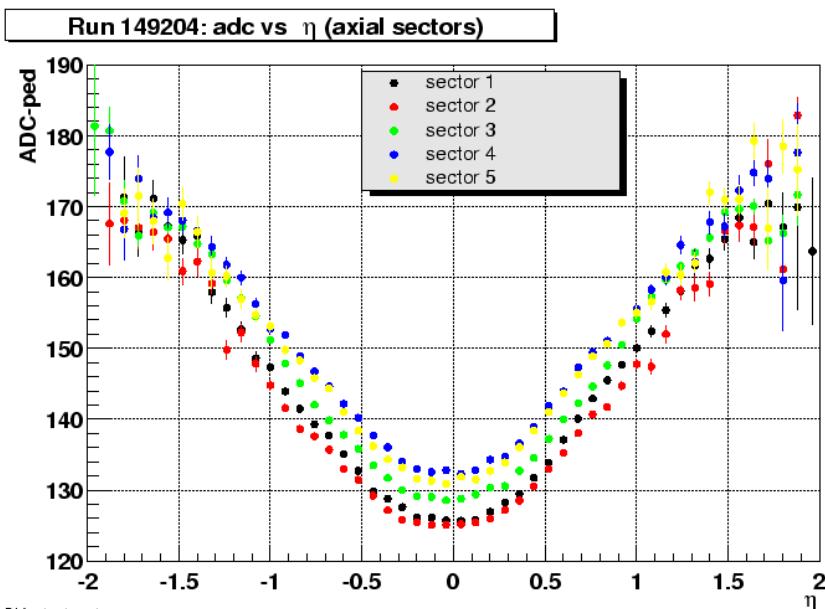
significant improvement expected from alignment with data in near future



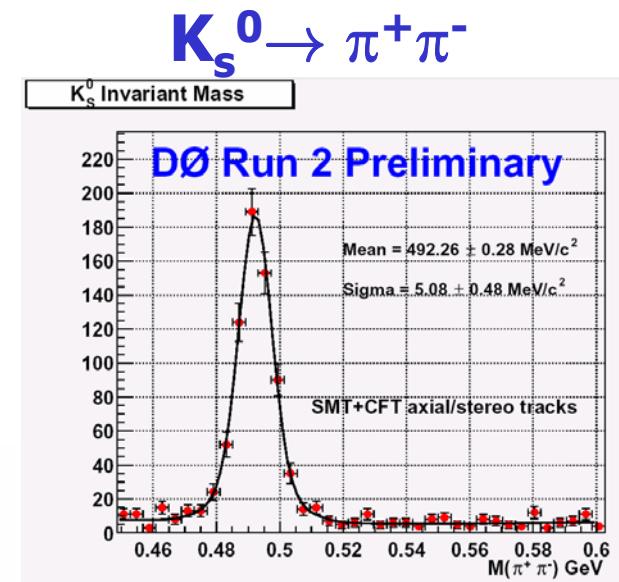
Detector Performance

- Fiber Tracker

light yield vs pseudorapidity η



Hit efficiency $\approx 98\%$



$Z \rightarrow ee$ candidate
Mass $89.9 \text{ GeV}/c^2$

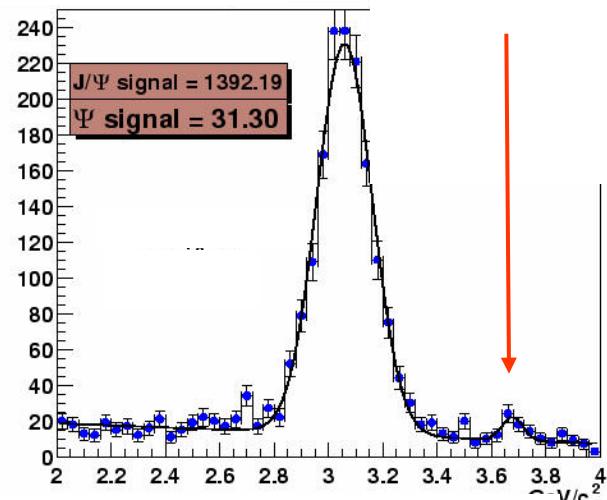
All tracking detectors working as expected



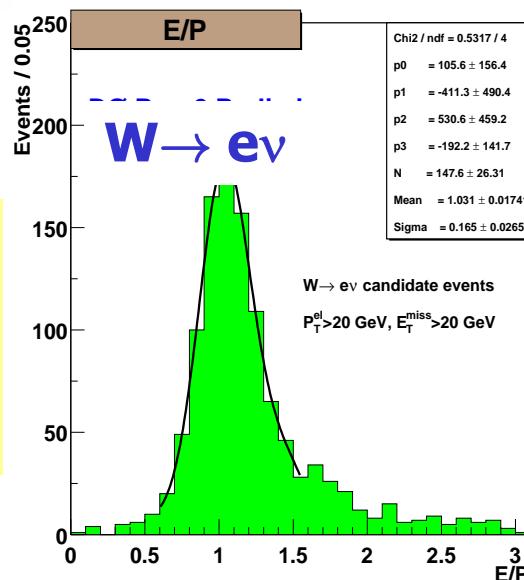
Detector Performance

- Muons

J/ ψ and ψ'

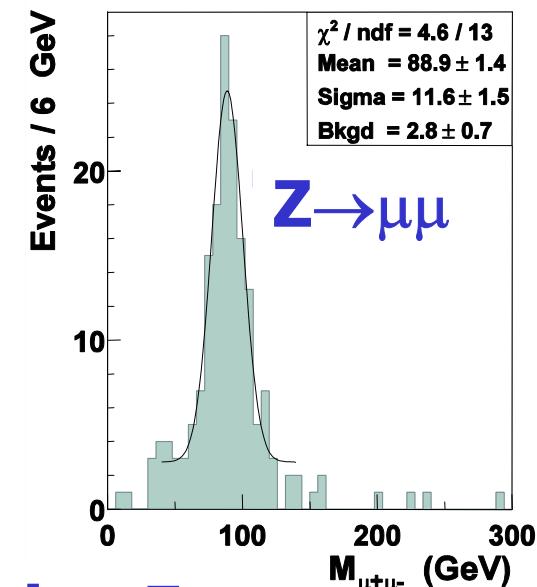


- Electrons

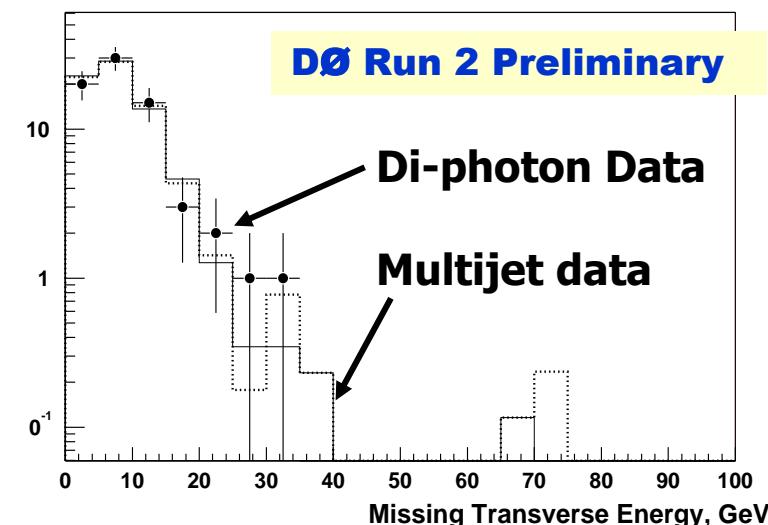


Detector performance consistent with expectations!

p > 15 GeV

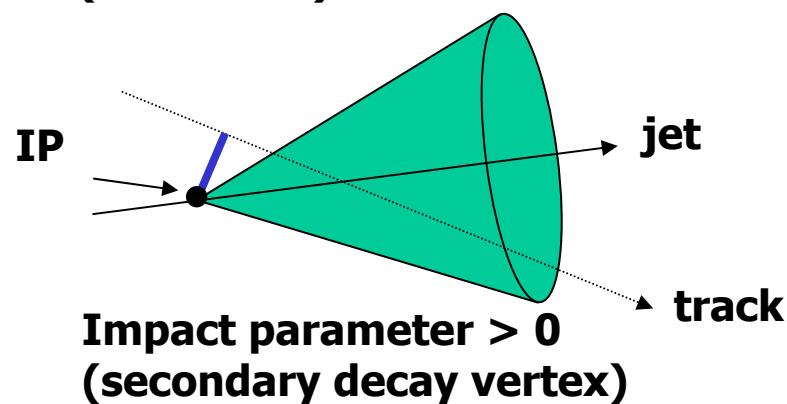
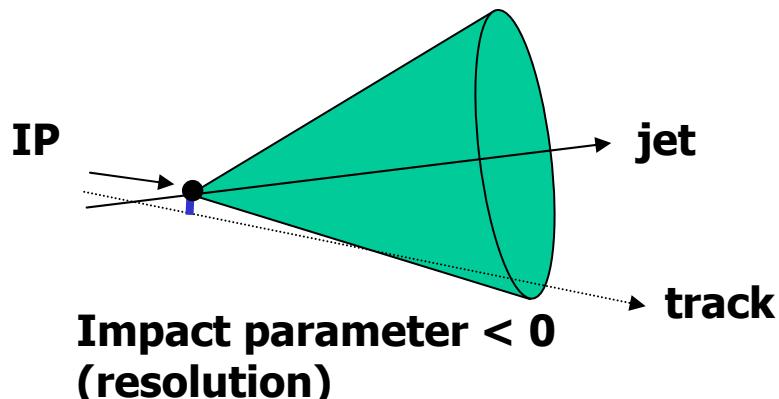


- Missing E_T

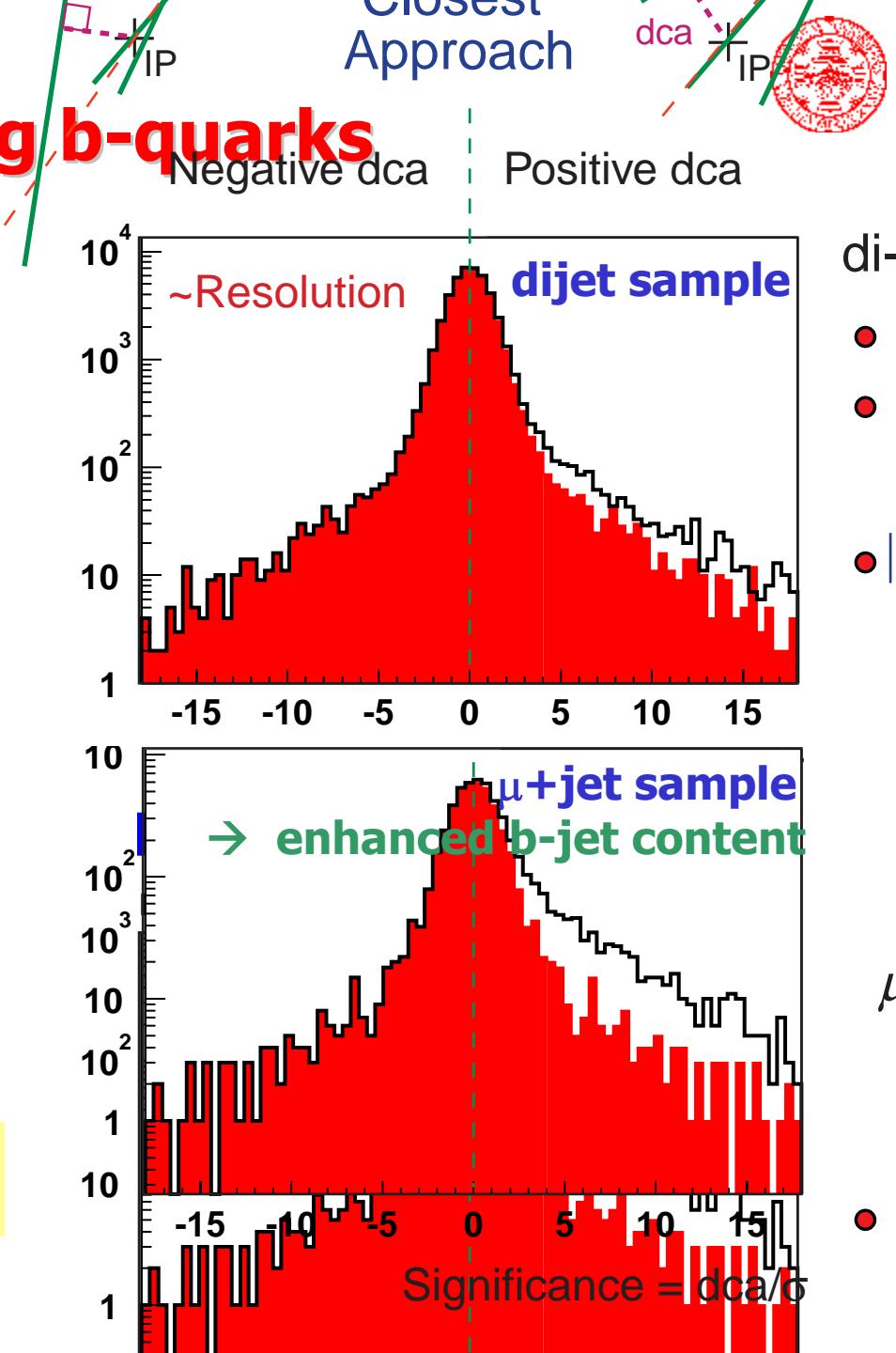


Identifying b-quarks

- Signed impact parameter



- Reconstruct secondary vertex
- Also use semileptonic decays





RunII Data and First Physics Results

- Delivered luminosity about 50 pb^{-1}
- Mostly used to commission detector
 - Now complete
- First results from about 10 pb^{-1} of physics quality data
 - New center of mass energy → measure cross sections
 - Exploit our High pT Physics capabilities at the energy frontier
- See also talks in parallel sessions
 - include results from both RunI and RunII



Dzero talks during the parallel sessions

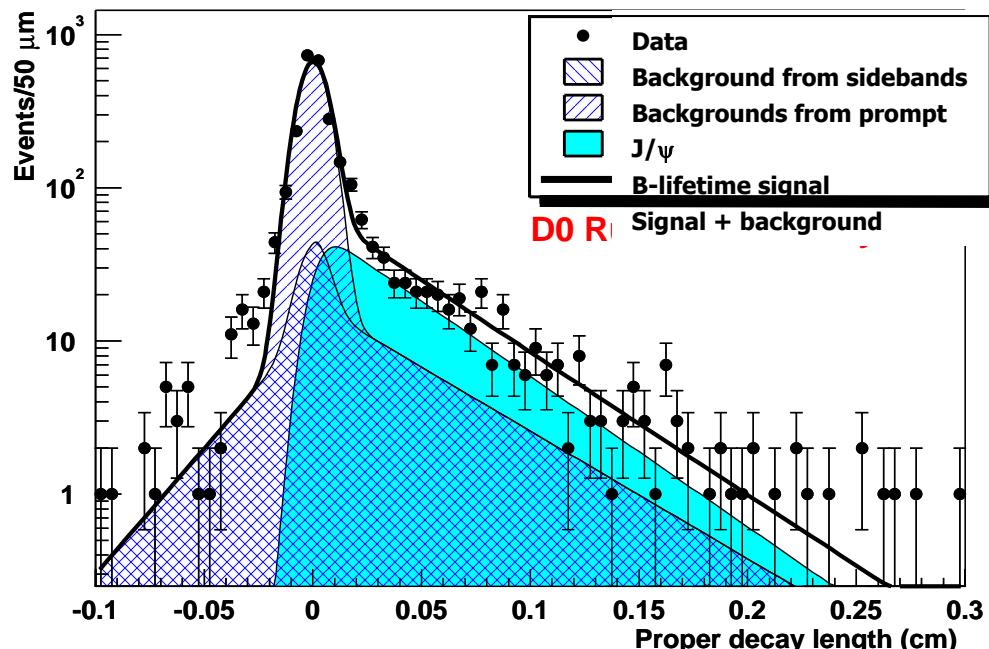
- Jet measurement with the KT method (**Ursula Bassler**)
- Minireview on Low Scale Gravity and ED at HERA/LEP/Tevatron (**Gregorio Bernardi**)
- Photon and Jet Physics at DØ (**Marek Zielinski**)
- Search for SUSY at the Tevatron (**Vishnu Zutshi**)
- W boson mass and width measurements (**Sarah Eno**)
- Top physics at the Tevatron (**Ia Iasvilli**)
- The DØ tracking system for Run II (**George Ginther**)
- The DØ detector for Run II (**Levan Babukhadia**)

- +... a few more talks by CDF speakers which include Dzero RunII results.

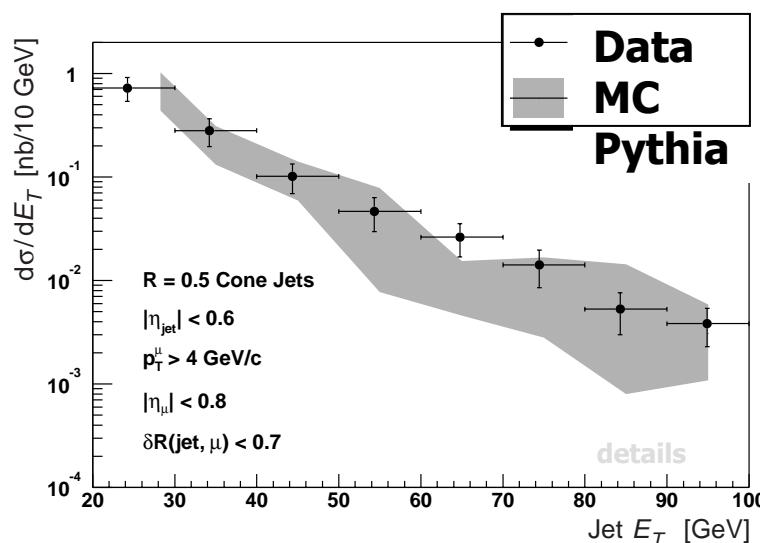


B-Mesons

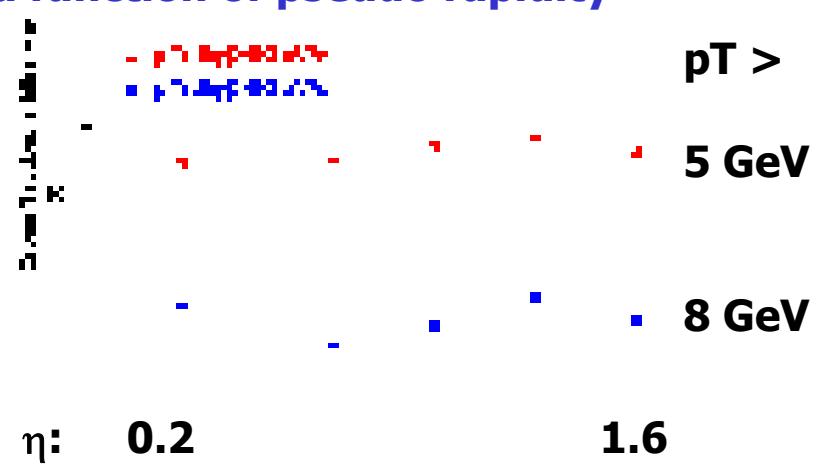
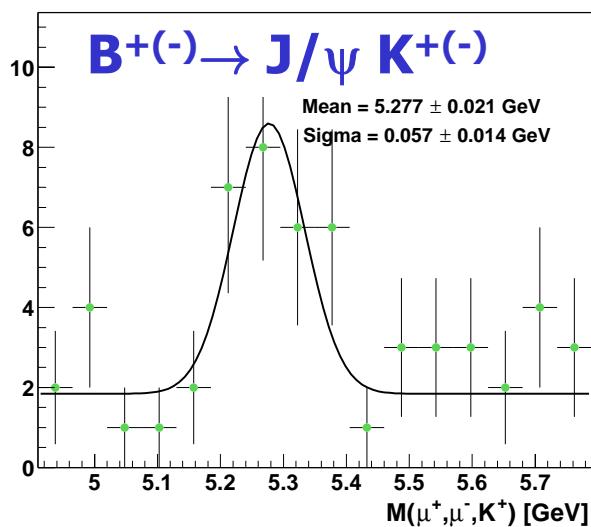
Average B Lifetime ($B \rightarrow J/\psi + X$)



$\mu + \text{jet}$ Production Cross Section



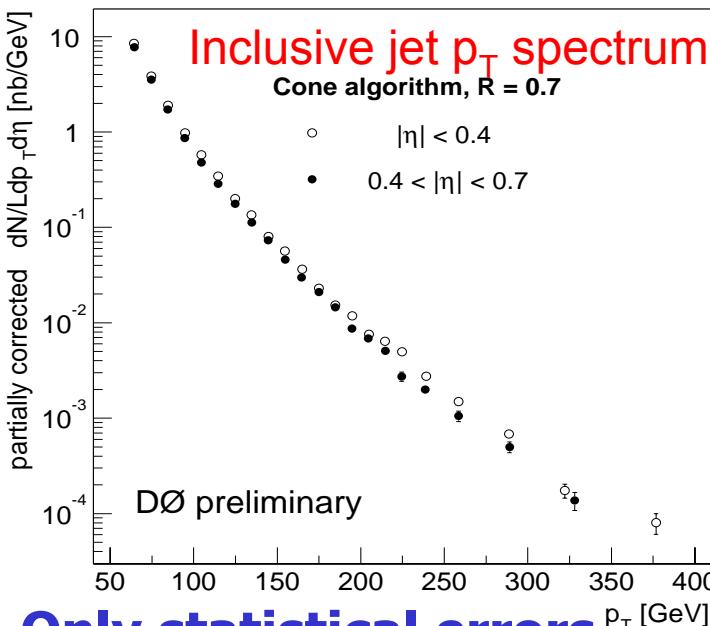
J/ψ production cross section as a function of pseudo rapidity





Jets Physics

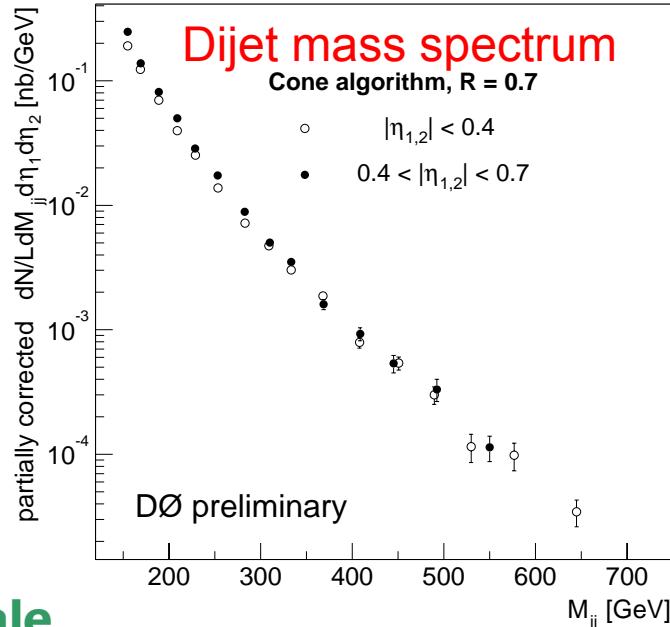
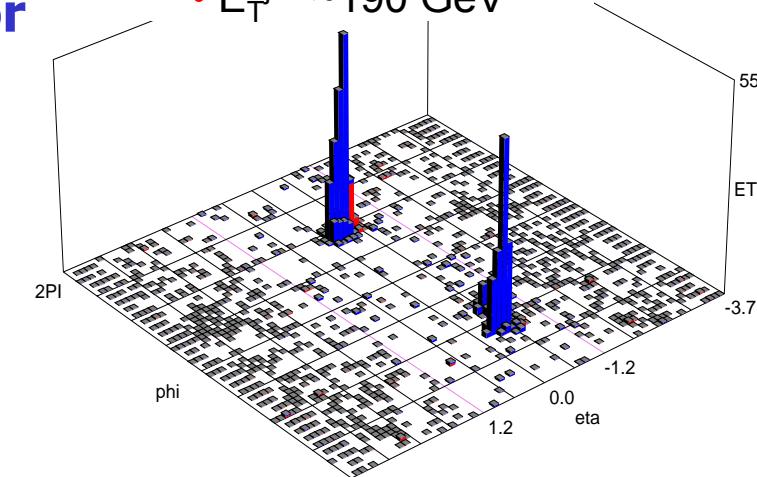
- At $\sqrt{s}=1.96$ TeV, cross section 2x larger compared to 1.8 TeV (Run I) for jets with $p_T > 400$ GeV



Luminosity
 5.8 pb^{-1}

2-jet event

- $E_T^{\text{jet}1} \sim 230$ GeV
- $E_T^{\text{jet}2} \sim 190$ GeV



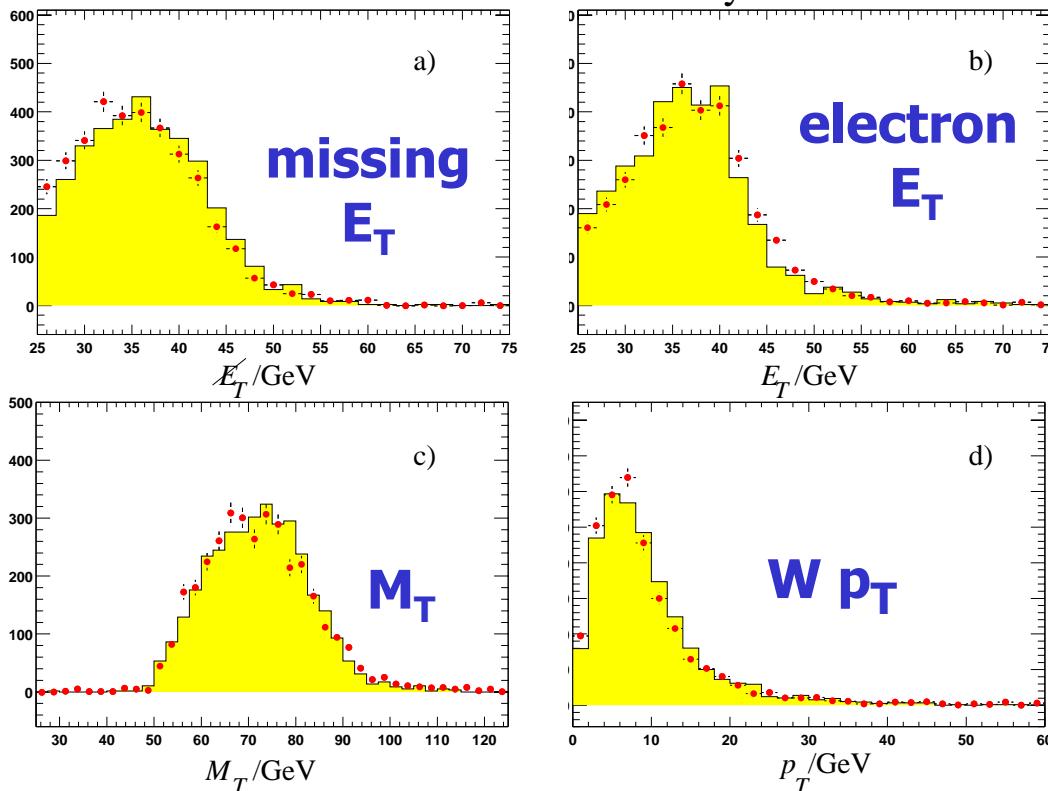
- Only statistical errors
- Preliminary jet energy scale
- Not fully corrected
- (for unsmeearing, efficiencies)
- In the works:
 - expanded η range, Improved energy scale...



W and Z boson production

W($\rightarrow e\nu$) event characteristics

D $\bar{\nu}$ Run2 Preliminary

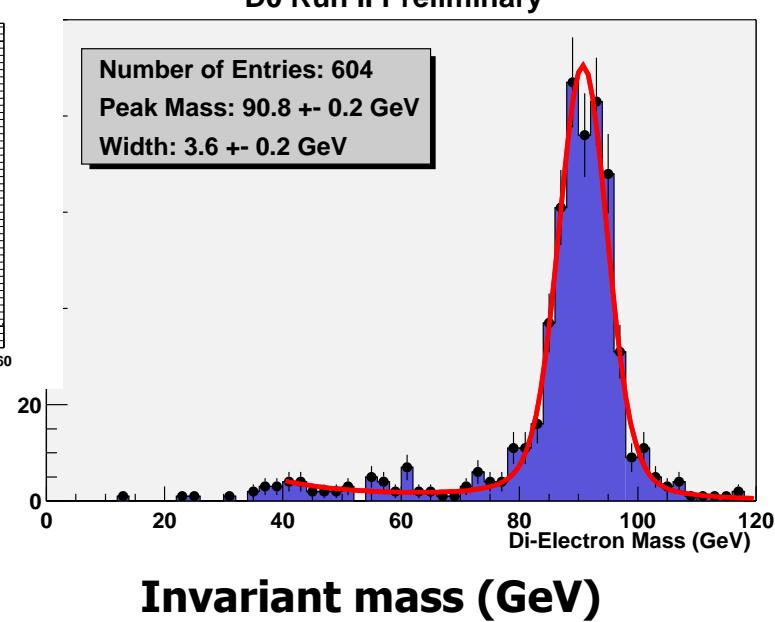


Distributions modeled well by MC

Red dots: Data
Yellow filled histogram: MC

$Z \rightarrow ee$

D0 Run II Preliminary





W and Z Boson production cross section

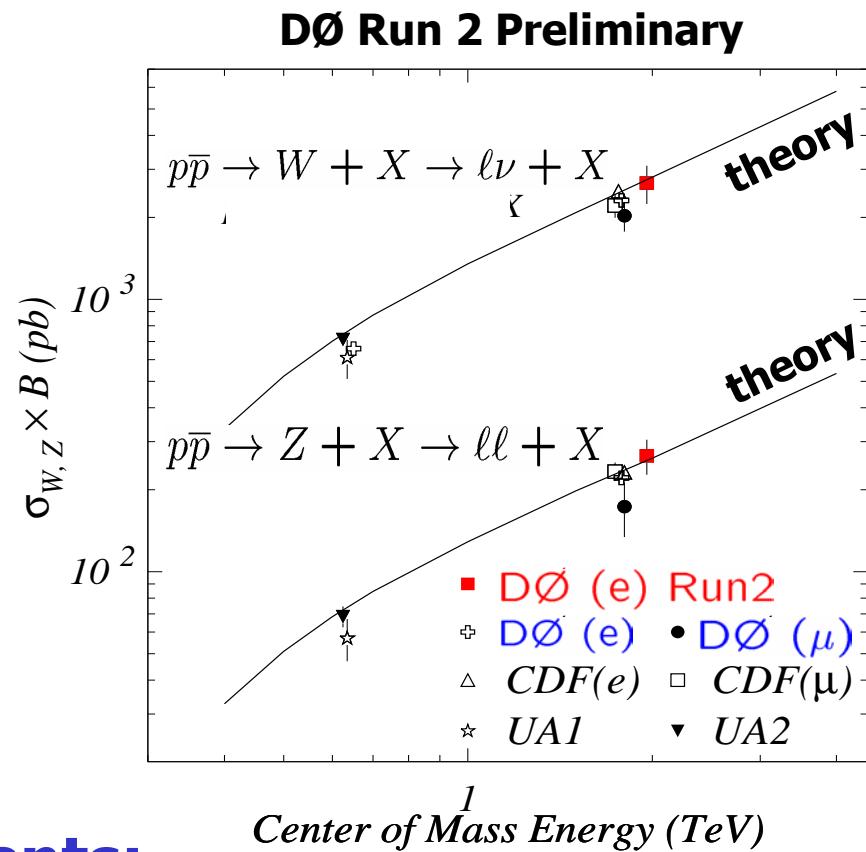
- **Data Sample:**

- Luminosity $\approx 7.5 \text{ pb}^{-1}$
- 9205 W candidates
- 328 Z candidates

- **Cross section measurements:**

$$\sigma_Z \times B(Z \rightarrow ee) = 266 \pm 20_{\text{stat}} \pm 20_{\text{syst}} \pm 27_{\text{lumi}} \text{ pb}$$

$$\sigma_W \times B(W \rightarrow e\nu) = 2.67 \pm 0.06_{\text{stat}} \pm 0.33_{\text{syst}} \pm 0.27_{\text{lumi}} \text{ nb}$$





W and Z Boson production cross section

- **Ratio of cross sections**

$$R = \frac{\sigma_W \times B(W \rightarrow e\nu)}{\sigma_Z \times B(Z \rightarrow ee)} = 10.0 \pm 0.8_{stat} \pm 1.3_{syst}$$

- **W boson width**

$$R = \frac{\sigma_W \times B(W \rightarrow e\nu)}{\sigma_Z \times B(Z \rightarrow ee)} = \frac{\sigma_W \times \Gamma(W \rightarrow e\nu)}{\sigma_Z \times B(Z \rightarrow ee) \Gamma_W}$$

- Using $\sigma(W)/\sigma(Z)$ from theory and $B(Z \rightarrow ee)$ from LEP

$$\Gamma_W = 2.26 \pm 0.18_{stat} \pm 0.29_{syst} \pm 0.04_{theory} \text{ GeV}$$

- In good agreement with world average:

$$\Gamma_W = 2.135 \pm 0.069 \text{ GeV}$$

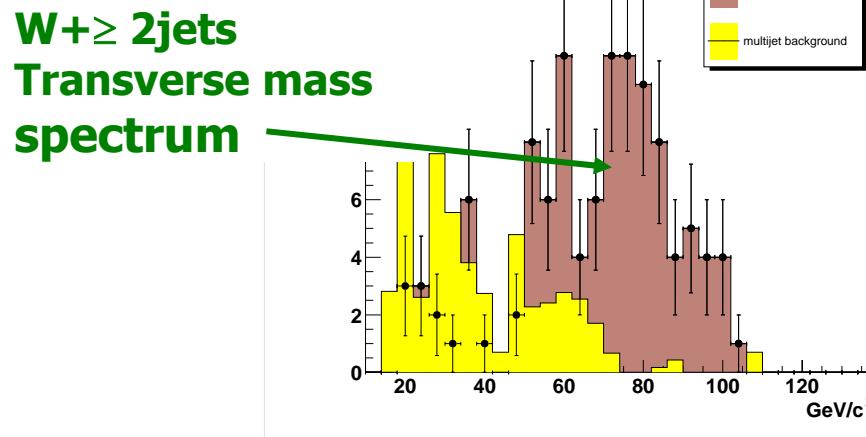
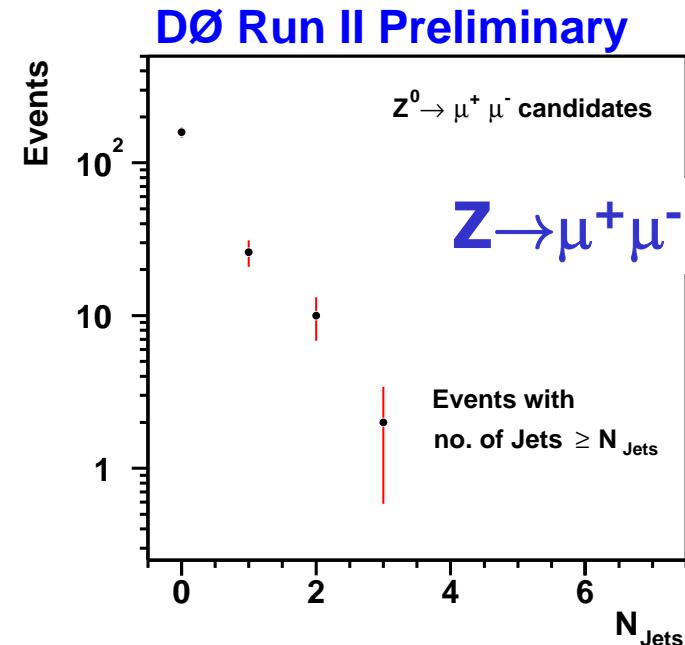
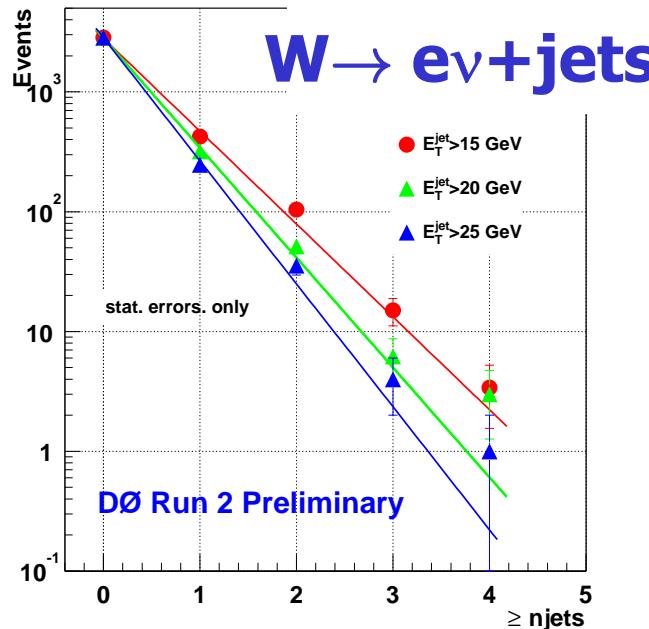
First results at 1.96 TeV





W/Z boson + multijet events

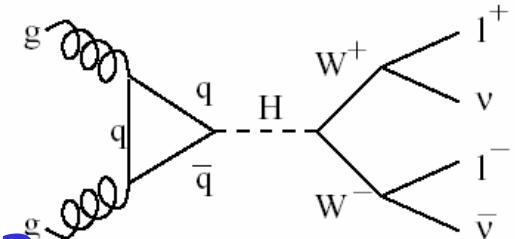
- Jet multiplicity distributions



- Top Physics:
 $W + \geq 3 \text{ jets}, Z + \geq 2 \text{ jets}$
- Higgs Physics:
 $W/Z + \geq 2 \text{ jets}$
- Need excellent b-jet identification
- Secondary vertex recons.
- Soft leptons in jets



$$H \rightarrow WW$$

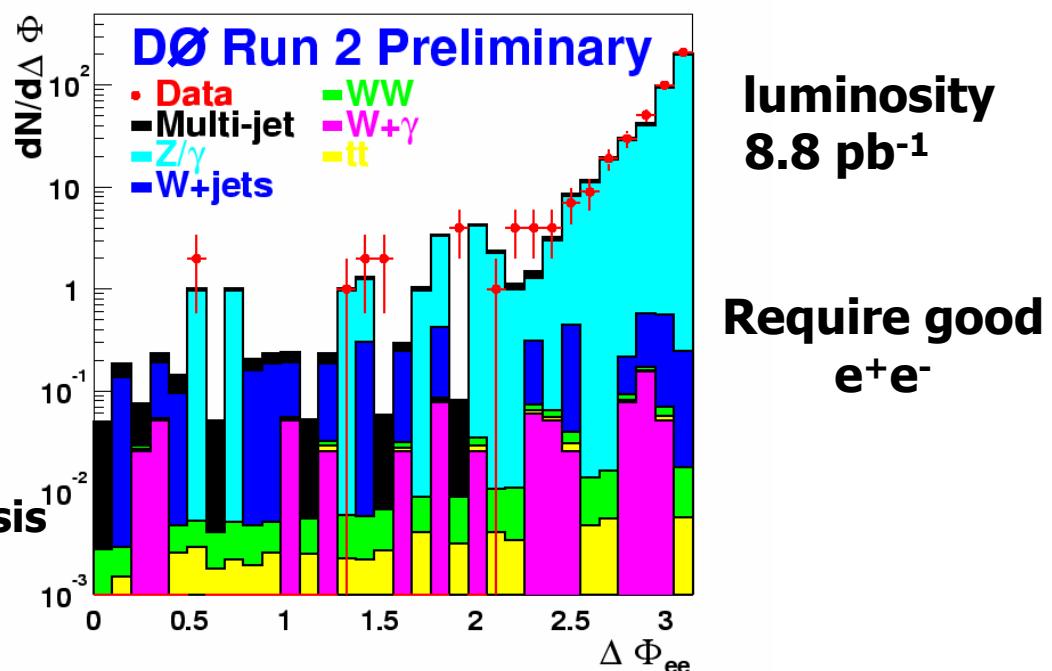


- Why $H \rightarrow WW$ at low luminosities?
 - 4th fermion family enhances SM Higgs cross sections by a factor of ≈ 8.5 for Higgs mass between 100-200 GeV
 - Fermiophobic Higgs: $B(H \rightarrow WW) > 98\%$ for $m_H \geq 100$ GeV
- Search for $e^+e^- + E_T$ events
- Understand Backgrounds for SM Higgs Search

Azimuthal opening angle
between the leptons

Observed events in our data and
estimated backgrounds
are in good agreement.

Develop tools necessary for analysis
Of larger data sets.



Search for Phenomena beyond the SM

- Many Analyses in progress:

- Likesign dielectrons

- Jets+Missing Et

- Tri-lepton signatures

- One of cleanest signatures of SUSY
chargino+neutralino production via W^*

- GMSB SUSY

$$p\bar{p} \rightarrow gauginos \rightarrow W, Z, \gamma + \chi_1^0 \chi_1^0$$

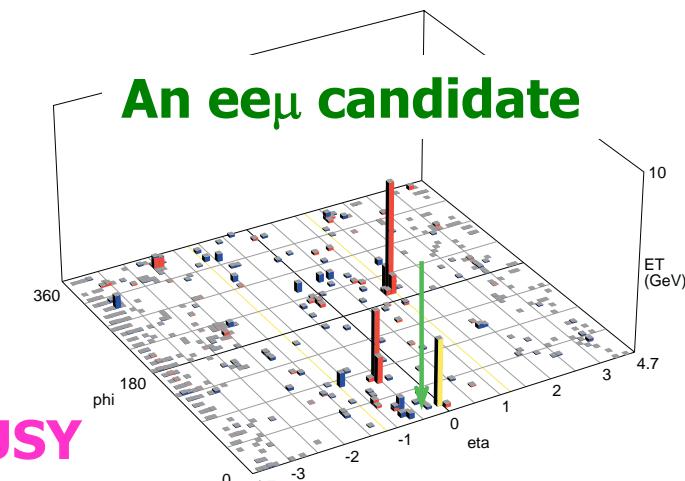
$$\rightarrow \gamma\gamma + \tilde{G}\tilde{G} + X$$

⇒ inclusive search for $\gamma\gamma E_T + X$

- Limit:

$$\sigma < 0.9 pb \quad @ 95\% \quad CL$$

- Sensitivity is still too low to exclude SUSY points

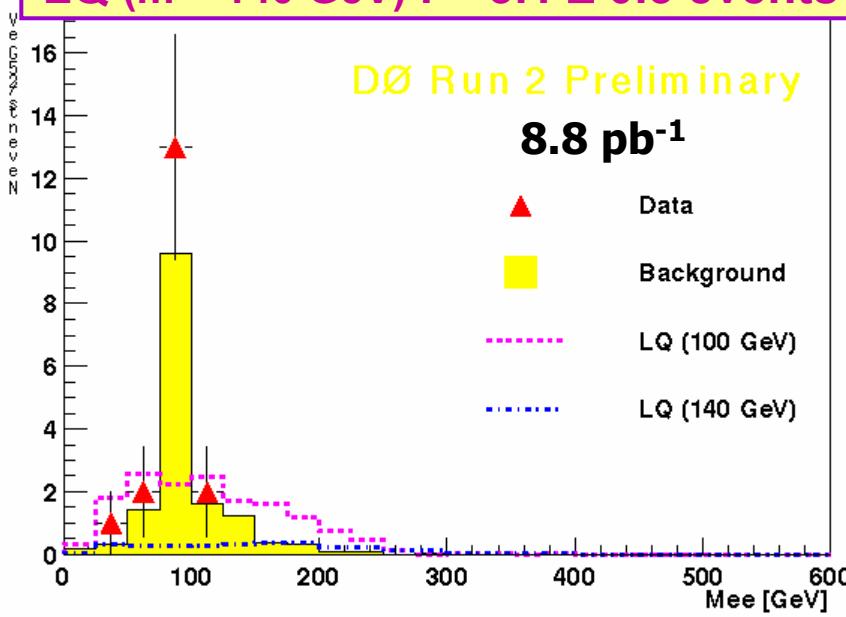




Leptoquarks

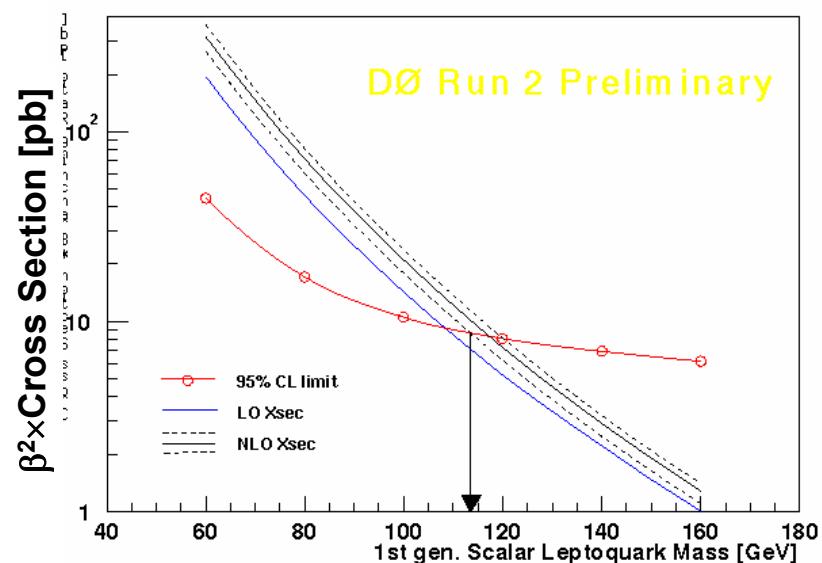
- particles with properties of both quarks and leptons; restore symmetry between the two
- Signature: eejj events

Data : 18 events
Background : 15.3 ± 5.3 events
LQ ($m = 100$ GeV) : 15.4 ± 2.0 events
LQ ($m = 140$ GeV) : 3.1 ± 0.3 events



6 candidates after removing Z

$M_{LQ} > 113$ GeV/c²
at 95% CL, for $\beta=1$

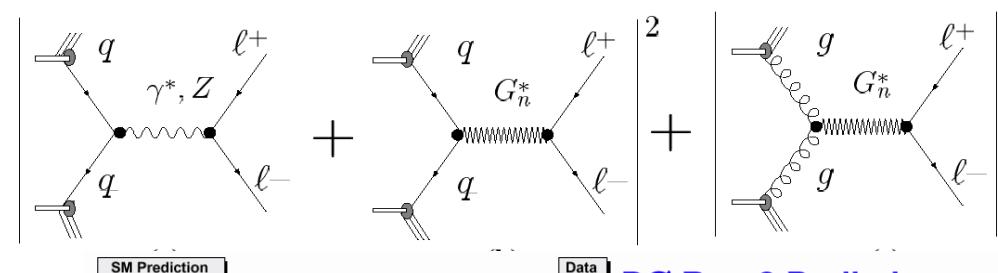


Consistent with our Run I result

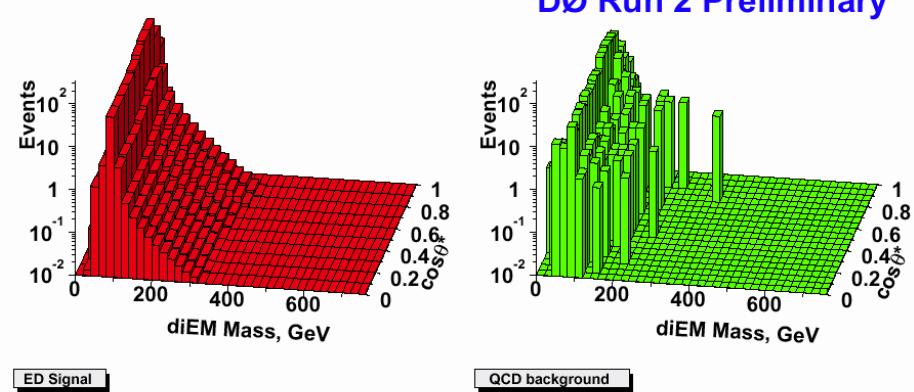


Extra Dimensions

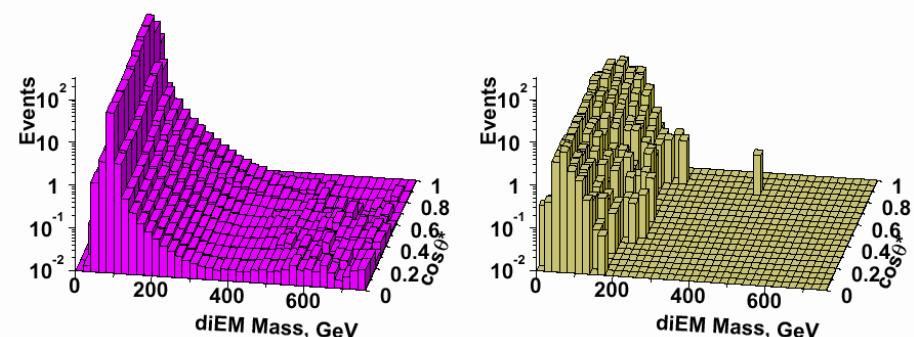
- Search for large extra spatial dimensions via virtual graviton effects
- e^+e^- , $\gamma\gamma$ and $\mu^+\mu^-$ events



- Run2 Preliminary Limit:
 - $M_{S(GRW)} > 0.92 \text{ TeV (ee, } \gamma\gamma)$



- DØ Run I limits:
 - $M_{S(GRW)} > 1.2 \text{ TeV}$





Future Prospects

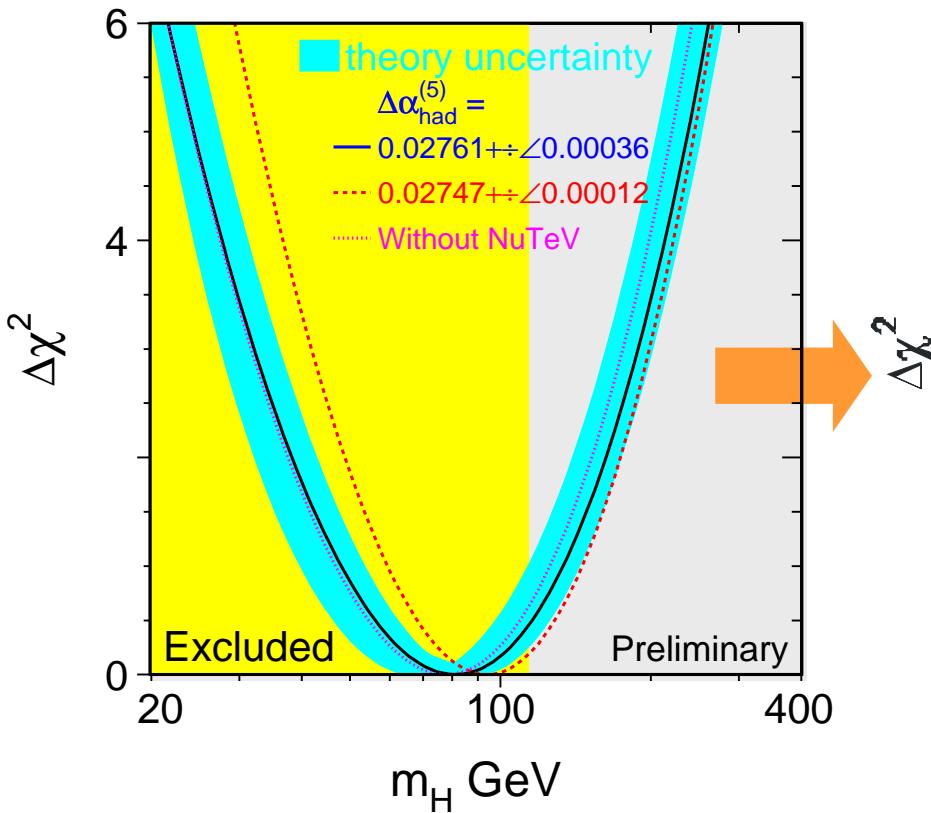
- Continue to Search for New Physics
 - SUSY, strong dynamics, others...
- Rich program of B-physics
- Measure W/Z Properties (A_{FB} , W mass to 30 MeV)
- Comprehensive study of Top quark Properties (2fb^{-1})
 - Cross section(7%), Mass (2 GeV)
 - spin correlations, charge, top-gauge boson couplings
- Precision measurements of Top quark and W Boson mass
⇒ constrain the Higgs Boson
- Direct Searches for the Higgs Boson
 - Run IIa: $M_H \gtrsim 115 \text{ GeV}$
 - Run IIb: $M_H \gtrsim 180 \text{ GeV}$ or see signal
- With 15 fb^{-1}
 - $\delta m_t \approx 1 \text{ GeV}$, $\delta m_W \approx 15 \text{ MeV}$, $\delta A_{FB} \approx 2 \times 10^{-4}$



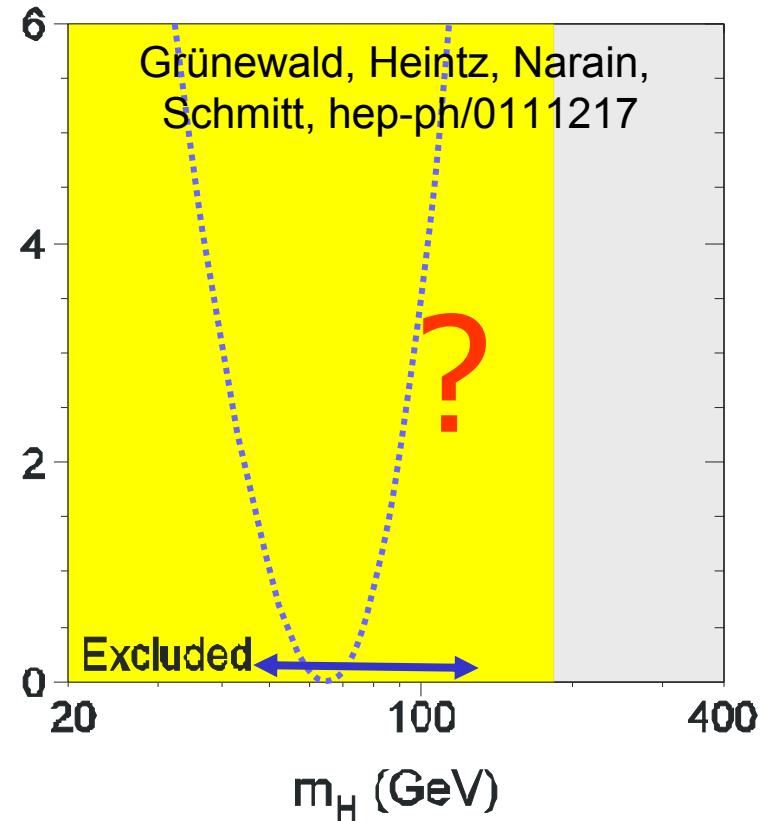


Can we exclude the SM?

summer 2002



\approx 2008



2

- current central values
- $\delta\Delta\alpha_{\text{had}}^{(5)}(M_Z^2) = 10^{-4}$, $\delta M_W = 20 \text{ MeV}$, $\delta m_t = 1 \text{ GeV}$
- could lead to inconsistency within SM framework



Thanks to my collaborators...



Institutions:
33 US, 40 non US

Collaborators:
334 from US
312 from non US institutions





Conclusion

- **First physics results at 1.96 TeV**
 - W and Z production cross sections
 - First generation LQ limits, Limit on Large Extra Dimensions
 - Lay foundation towards measurement of:
 - B lifetime, b-quark cross sections, jet cross sections
 - Many High p_T analyses in progress awaiting more luminosity
- **Enormous progress made over the last year**
 - detector performance optimization
 - developing analysis tools
- **Improvements in store:**
 - optimization of event reconstruction and selection procedures
 - Triggers and DAQ performance,
 - calibration, and alignment of the detectors
- **Looking forward to collecting large integrated luminosity !**

